"On a Relation between Autumnal Rainfall and the Yield of Wheat of the Following Year.—Preliminary Note." By W. N. Shaw, Sc.D., F.R.S., Secretary of the Meteorological Council. Received February 2,—Read February 2, 1905.

By autumn, in this note, is to be understood the period from the 36th to the 48th week, both inclusive, of the year, as represented in the *Weekly Weather Report* of the Meteorological Office; it covers the months of September, October, and November, approximately. The rainfall to be referred to is the average amount in inches, for the "Principal Wheat Producing Districts," for the period mentioned, in successive years. The amounts are taken from the summaries of the *Weekly Weather Report*.

The yield of wheat is that given for successive years in the annual summaries of the Board of Agriculture and Fisheries as the average yield in bushels per acre for England, since 1884, or more strictly since 1885, as that is the first year for which the figures for England are given separately. In 1884 the figure for Great Britain, which generally differs but little from that for England, is used.

These are the only figures in the official publications which are immediately available for the purposes of comparison. The totals of rainfall for the 13 weeks have been compiled from the weekly amounts, otherwise the figures are taken as they stand in published returns. The areas referred to are not exactly coterminous, but they are more nearly so than if the rainfall values had been taken for the whole of England, or the wheat yield for Great Britain.

When the autumn rainfall and the yields of wheat for successive years from 1884 to 1904, as thus defined, are plotted, the rainfall curve being inverted, *i.e.*, rainfall being measured downward on the paper while yield is measured upward, there is a very striking similarity between the curves, so much so as to suggest that if the scales were suitably chosen the two curves would superpose and show general consonance, with exceptions, more or less striking, in a few of the years. In other words, the yield of wheat in any year seems to depend mainly on the absence of rainfall in the previous autumn, and but little on any other factor.

The obvious algebraical expression for such a condition as the curves represent is a linear equation, and the equation which represents the relation between yield of wheat for England and the previous autumn rainfall is:—

Yield = 39·5 bushels per acre − 5/4 (previous autumn rainfall in inches).

If we call the yield obtained from the rainfall by this equation the

"computed yield," a comparison with the actual yield for the 21 years shows that the computed yield agrees with the actual yield within half a bushel in 7 years out of the 21. In 14 years the agreement is within 2 bushels; in the remaining 7 years the difference between computed and actual yield exceeds 2 bushels. The extreme variation of yield in the 21 years is 9 bushels, from 26 bushels per acre in 1892 and two other years, to 35 bushels per acre in 1898.

Of the 7 years for which the formula gives yields differing from the actual by upwards of 2 bushels, 1896 is the most conspicuous, its actual yield exceeds the computed yield by 4·5 bushels.

These 7 years all show anomalous seasons. Taken *seriatim*, they are 1887, 1888, 1893, 1895, 1896, 1899, and 1903.

In 1888 and 1903 the crops were washed away by 10 inches of rain in the summer; 1893 is the year of phenomenal drought and the crop was below the computed figure by 2·5 bushels. The years 1892 and 1899 are interesting, because though the amounts of rain were up to the average, the former had 8 dry weeks and the latter 10 dry weeks out of the 13 included in the conventional autumn. They were thus dry autumns, the average amount of rainfall being made up by a few exceptionally wet weeks. The yields correspond with dry autumn values. They are above the average and above the computed figures by some 2 or 3 bushels per acre.

There remain 1895 and 1896. 1895 was the year of remarkably cold weather, and in that year the yield fell short, but in the following year the deficiency was made up by a yield as much above the computed value as the previous one fell short. It would appear that in this instance the productive power not utilised in the year of the great cold was not lost but stored. On the other hand, it must be remarked that 1896 had the advantage of a specially dry winter.

It appears from these considerations that the dryness of autumn is the dominant element in the determination of the yield of wheat of the following year. The averages of yield and of rainfall are taken over very large areas, and it may be taken for granted that the investigation of the question for more restricted areas would introduce some modification in the numerical coefficients, if not in the form of the relation.

The data for making such an investigation are not yet in an available form. A comparison has been made between autumnal rainfall for "England, East" and the average yield for the counties of Cambridge, Essex, Norfolk and Suffolk, which shows a similar relation but a magnified effect of autumnal rainfall upon the crop, and also two exceptional years which have not yet been investigated.